A NEW MOVEMENT AMONG PHYSICS TEACHERS

CIRCULAR III

Notwithstanding the fact that the answers to the questions in Circular II were asked for during the summer vacation, when a teacher wishes to be rid of all thoughts of teaching, 130 answers were received. These came from 83 high schools, 9 normal schools, and 38 colleges. The geographical distribution of those who answered is very similar to that published in the last circular, nearly every state in the Union being represented.

The tabulated summary of the answers received is as follows; the numbers in parentheses indicate the number of votes in each case:

Question 1. The replies to this question concerning the best methods of keeping notebooks were generally very full, showing that a large amount of attention is being given to this important matter by the teachers.

Many believe that the student should not be asked to make out his own form of report (9), but should record his results in printed tabular forms (25). On the other hand, others think that the printed forms should not be used (35); but that the student should be required to work out his own form after a few weeks of drill and experience under the guidance of the instructor (60). It is suggested that if the student is encouraged to describe his work in his own way—so that he feels that he is book-making rather than book-keeping—he will take pride in his work (8), and he will record only work that is distinctly his own (9). In any case, the report must be concise (12), well systematized (11), contain no descriptions of apparatus (9), no drawing (9), no details of the method of performing the experiment (5), and no copying from the manual (5).

The time of the teacher may be saved by having the student hand in his results immediately and having them inspected during the laboratory period (24); in which case a loose-leaf manual or notebook, with drawing of the apparatus but not much description of the experiment, is desirable (22). Time may also be saved by using the graph for tabulation of data (6); by so co-ordinating the experiments that the result of one checks that of another (2); by not requiring the student to attempt to write a description of things he does not understand (3); and by letting the student give oral explanations instead of written ones, the data and conclusions only being recorded (3). Three suggest that only one out of six experiments be written up in full, the rest being reported on tabular printed forms.

As to the minimum requirement, four vote for 40 experiments, five for 30, and ten for 20; it being understood that these are all quantitative. Six urge that

no notebooks be required by the colleges for entrance, but that the certificate of the school be sufficient. The minimum record for a report of an experiment should contain: (1) purpose (34); (2) list of apparatus (12); (3) drawing or diagram (21); (4) description of the method of work (27); (5) tabulated data or results of measurements (33); (6) discussion of data and conclusions (35); (7) discussion of errors (5); (8) answers to questions by the instructor (2); (9) historical notes (1); and (10) meaning of experiment to student (2).

Question 2. Every one of the answers to this question stated that the amount of subject-matter usually compressed into the one-year course is too great. The methods of reducing it may be summarized as follows:

By omitting either the parts that are largely mathematical (21); or the more abstract parts (17); or the less essential parts (20); or one whole division of the subject (13). We might also cut out descriptions of antiquated apparatus (3), fads (4), special rules (5), work belonging properly to the college (4) or to the technical school (5). We should introduce only the simplest and most necessary units (3); omitting the dyne, the erg, the poundal, etc. (7). We might also omit the parts that are not easily understood (7), suppress all unnecessary detail from the textbooks (3), and reduce the discussion of mechanics to half the space usually given it (2).

Simplification might also be obtained by a better organization of the subject-matter (7); for example, by making the idea of energy the center and grouping the other material about this (4); or by intensifying the parts that are immediately connected with the student's life (7). The facts and laws studied should be limited to fundamentals—no physics curios (6), or to facts which clearly relate to the life of the students rather than to the laboratory (5). There should be more laboratory work on fewer principles (2), more study of phenomena first (15), and no principles should be given till the phenomena which they resume are clearly grasped (5). We should evaluate the work less by the amount of ground covered and more by its quality (3). It might also be well to conduct the course by assigning no lessons from the text, but rather giving a series of problems that necessitated for their solution a study of the text (2). A course might be devised consisting simply of forty typical experiments with questions and problems on the practical application of the principles involved (2). Others think that the reduction should be different in each school, being left entirely to the teacher (3).

Some claim that the method of presentation is vastly more important than choice of subject-matter, so that a few things well presented are of more value than a large number poorly done (7), while others claim that it is important to give a general survey of the whole field, even though parts of it are not appreciated at the time (2).

Question 3. Of those who answered this question, 47 prefer to have physics in the fourth year, 25 want it kept in the third year,

and 12 want it in both. Fourteen suggest that there should be a simple descriptive course in the first year, to be followed by the present course in the fourth.

Question 4. The vote on the question as to how much of the time should be spent in laboratory work was as follows: one-fifth (5), one-third (28), two-fifths (28), one-half (33).

Question 5. This question brought out many valuable suggestions as to what the associations might do to help the teacher in perfecting his work. Some of these are as follows:

The associations should organize a campaign for the education of the public, the superintendents, the principals, and other school authorities concerning the conditions necessary for efficient work in physics; namely, the teacher must have a free period immediately before a demonstration lecture (17); also time to pre pare for the laboratory work (18); also, because of the time required for the satisfactory care of the apparatus, he should have one hour a day less teaching than those who do not have to work with apparatus (29). Statistics should be gathered as to the weekly hours of work by physics teachers and by others (28), and also concerning the apparatus and equipment of the schools where satisfactory work is done (3). Membership in an association should give a teacher rank and standing (9); so that people recognize that he is not the mechanician, carpenter, janitor, and scrub-lady combined (2). Through the associations the teachers should also control the ways of entering the profession, as is done in medicine, law, theology, etc. (4). One suggests, "Why not have a Union?" The associations could also help in insisting on double periods for laboratory work (4), and in securing more time for the subject in the curriculum (2). They might also unite in the production of a satisfactory text (1), and in helping the teacher to free himself from set forms and syllabi (7).

The colleges might also be reached by the associations, and persuaded to accept for entrance the work done by the high schools as the high-school teachers see fit to do it (19); and to lay more stress on the quality of the work rather than on its quantity (8)—perhaps they might be seduced into accepting twenty topics well understood in place of forty experiments as the *sine-qua-non* of entrance.

The associations could assist the teacher by publishing a teachers' manual (8), by issuing circulars telling how experiments may best be done (3), and by keeping up the present agitation (10).

Question 6. Many possible forms of syllabus were suggested in answer to this. Although two think the syllabus a delusion and a snare, most believe that one might be framed that would help rather than hinder the teacher. Here are the suggestions:

The syllabus should consist of a number of fundamental principles, together with a requirement of the comprehension of a certain minimum number of them,

and a long list under each of means and methods of teaching that principle; and then leave the teacher free to select both the principles he will teach and the means of doing it (26). It should be intensive in each subject and require only 60 per cent. of it (3). The syllabus must contain a much larger number of experiments than required for a year's work, and leave the teacher free to select (22). Such a list of experiments should be accompanied by an obligatory minimum requirement (4), but it must be flexible (15), and allow substitutions (10). It might outline the essential parts, giving references, and let the teacher fill in (5).

Instead of a syllabus, it might be better to approve a score of textbooks, and trust the teacher for the rest (3); or, we might simply draw up a comprehensive and varied list of questions for the pupil to be able to answer (3). Only about half of those who replied attempted to answer this question.

Question 7. The purpose of instruction in physics is a matter on which there is wide diversity of opinion, as may be seen from the following summary of the replies:

Physics instruction should bring the student into intelligent touch with the world of natural phenomena about him (30), give him some comprehension of the working of practical and familiar things (17), increase his knowledge of fundamental facts (14), teach him the fundamental laws of physics (18), rationalize his knowledge of phenomena (7), show him that Nature works by law (10), reveal to him the vast extent of the unknown (2), and bring him to appreciate the limitations of experimental accuracy—man's handicap (2).

Such instruction should also develop reasoning power (26), logical thinking (2), ability to detect and use laws (9), interest in the applications of laws (6); powers of close observation (15), of interpreting observations (15), of solving problems for himself (6); and powers of doing things and of taking the initiative (5). It should also foster the scientific method of thought (14), arouse the imagination (2) and the love for beauty and truth (3); it should develop accuracy in measurements (6), computation (5), and expression (4). It should show him the value of accuracy (2) and of quantitative knowledge (2), and the desirability of testing things by measurement (3). One suggests that the first six or seven months' study should be purely informational, and the rest review, since reasoning begins later. Two others lay stress on showing the student that scientific knowledge increases our power over things by enabling us to predict what will happen under a given set of conditions. Finally, two think the purpose of the physics course is to teach physics.

The most important suggestion as to the method of testing whether the aim of the course has been attained is this: that the teacher observe the pupil and study his work (18), and then judge his acquirements by his interest in physics problems outside the laboratory (6), and his power of solving simple original problems (7). It is suggested that there should be frequent short tests (10), careful inspection of the notebook (9), and a final examination (5) which is framed to test power of thought rather than memory (4). One suggests that a committee of the asso-

ciations should frame the examination questions, which should concern themselves with broad general principles only. Three others call for no final examinations, but suggest quizzes on practical subjects. Five want the colleges to accept the certificate of the school without special examination by the college. Five others suggest as a suitable form of examination the requirement of the description of a new machine or piece of apparatus.

Question 8. The following suggestions as to what associations could do to encourage teachers to take membership in them were submitted:

The programme should be made up of interesting papers with discussions (10); the subjects treated should be concrete problems met with in actual works (8), not academic discussions (3), nor yet long-winded papers supposed to be instructive (5); but more heart-to-heart talks in which the teachers are not lectured to but engaged in conversation (3). To encourage attendance the meetings should be held at other times than Thanksgiving and Christmas (2), and the schools should pay the expenses of the teacher, besides giving him the necessary time off (5); or else pay better salaries, so he could afford to go (10).

Interest should be kept up between meetings by printing and distributing bulletins of practical import (15), or by a running discussion by means of circulars like these (17). The transactions should be printed in full (5), and the association should be so administered that the teacher could not afford to miss it (7). All members should be put to work, so that each feels that the association needs him (18); and local centers should be formed for more frequent meetings (6). The general meetings should be held in different parts of the state each year (5), and the offices should be passed around (5). Visits to manufacturing plants (3) and apparatus exhibits (5) add to the interest.

The meetings should be less formal (2) and the social element should be prominent (7). Attendance on meetings should be required by the schools (3) or the teacher asked to resign (2). All should take the teachers' journal and read it thoroughly (6).

To anyone who has read the summaries of these answers, together with those printed in Circular II, it must be very evident that physics teachers are far from agreed as to the aims, methods, and needs of their work. Under these conditions it seems unwise to attempt to frame a detailed outline of a course until we can agree on some general propositions. Since work similar to this has been going on in both Germany and France for some time, it has been suggested that perhaps we can accept first some of the broader principles on which the German and French Associations have agreed as of fundamental importance. The theses proposed below are not literal translations of the German and French ones, but have been rewritten to

meet American conditions as revealed by this discussion. The foreign theses may be found in the article by Young in *Science* for May 18; or more fully in the *Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht*, Vol. XXXV, p. 359; Vol. XXXVI, p. 539; and in the *Conférences du Musée Pédagogique*, 1904. The remarks in parentheses signify the vote of the committees.

1. The subject-matter of the first-year course must be reduced to two-thirds its present amount, or else the time allowed for covering it increased to one and one-half years. (Not necessary, 1; increase the time, 3.)

2. If the subject-matter is reduced, the more abstract, mathematical, and technical topics, i. e., those that have no possible bearing on the student's life, should be first eliminated. The better-established portions of the subject should have precedence over the more recent unproved speculations, on the ground that in the limited time it is better to teach things which are likely to be still believed when the youngster is grown up.

3. In the first-year course the method of presentation is of far greater importance than the choice of subject-matter; i. e., it is better to present a few topics in such a manner that they are powerful examples of the method by which science obtains its results, than to try to teach a large number of more or less scattered facts and theories in such a way that they can only be committed to memory. (In line 2 change "choice" to "amount," 2.)

4. No definition should be introduced until the concepts with which it deals have been clearly developed in the student's mind by means of a discussion of concrete cases from the student's own world. In other words, a definition must be justified before it is stated, not after. (Not wholly, 3.)

5. No law should be stated until the concepts and relations with which it deals have been implanted in the student's mind by a discussion of common experiences and of simple qualitative demonstrational experiments. After the concepts and the idea that there may be a quantitative relation among the factors involved have been grasped, the quantitative relation may be stated and proved either by demonstration or laboratory experiments. In other words, the student must be given an intuitive and qualitative perception of the relations summarized by the law, before he is expected to comprehend and use it intelligently. (Too sweeping, 1.)

6. The student should be made to see clearly that laboratory apparatus furnishes the means of determining quantitatively the relations summarized by laws. He should also be made to see that the apparatus is not the law, that it is not necessary to remember the details of the apparatus in order to appreciate the law, and that the exemplifications of the law are not confined to the apparatus.

7. The student should be made to comprehend that every law has been established by a method of approximation, so that the statement of law is always a statement of what we believe to be true in an ideal case. Hence the measurements by which the law is established give results which approach more and more nearly to the law, the more carefully the measurements are made, and the more completely complicating effects are eliminated. He should also understand that in every practical case the law is not verified because of friction, air resistance, etc.

8. Measurements of the relations involved in practical cases lead to determinations of efficiencies, rather than to the verifications of laws. Such determinations of efficiency furnish for the laboratory work problems which are of great value and interest because of their reality.

9. As few units as possible should be employed, and they should be introduced only when a necessity for their use appears; i. e., their introduction should be justified in advance as in the case of definitions. By this thesis the more abstract units like the dyne and the erg would be ruled out of the elementary work. (Do not omit the dyne and the erg, 5.)

10. Examinations and quizzes should be framed to test the student's comprehesion of and ability to use the more important principles of physics. The questions should not be asked for mere statements of laws from memory; nor should they contain complicated arithmetical puzzles of the sort that never occur in practical work. They should not demand descriptions of laboratory apparatus, nor of unrelated facts which do not have any immediate bearing on the principle involved. They should rather consist of questions as to the arguments by which a principle is established, and as to how the principle is applied in daily life; also of simple problems, which deal with immediate concrete applications of the principle, and which are of the kind likely to be met outside of the class-room or laboratory. (Not the second sentence, 1.)

It is proposed to use these theses, or such others of like nature as the physics teachers may elect, as a preamble to the new syllabus. All who are interested in this work, and who wish to help it along, are invited to send approval, disapproval, criticisms, additions, or other suggestions concerning them to the committees. Such answers must be sent in promptly, as the new syllabus is now being drawn up. They should be in not later than November 15.

This circular is being sent, in consideration of the fact that the summer is not the time to work teachers, to all who have answered either of the others. The new proposed syllabus will be ready for distribution about December 1, and will be sent to all who take enough interest to answer this one or to signify their desire to receive it. All communications concerning this should be sent, as before, to C. R. Mann, Ryerson Laboratory, University of Chicago.

Since sending out the last circular, three associations have added committees to the list as follows:

The Indiana State Science Teachers' Association: Messrs. B. L. Steele, High School, Marion; J. P. Naylor, DePauw University, Greencastle; and W. A. Fiske, High School, Richmond. The Pacific Coast Association: Mr. P. T. Tompkins, Lowell High School, San Francisco. The Eastern Association of Physics Teachers: Messrs. F. M. Gilley, High School, Chelsea, Mass.; J. A. Coolidge, English High School, Cambridge, Mass.; J. W. Hutchins, High School, Malden, Mass. Mr. W. A. Hedrick, Central High School, Washington, D. C., has also been appointed by the physics teachers of Washington, D. C., to represent them in this movement. The membership of Committee of the North Central Association has been increased by the addition of Messrs. G. H. Mead, University of Chicago, Chicago, Ill.; M. V. O'Shea, University of Wisconsin, Madison, Wis.

In order to facilitate the work, the joint committees have voted to organize themselves into a commission. The organization that has been agreed on is as follows:

1. All the subcommittees agree to unite into one large committee to be known as the National Commission on the Teaching of Elementary Physics.

2. Each member of a committee appointed by an association for this work shall be a member of the commission.

3. Each member of the commission shall have one vote.

4. Vacancies in the commission shall be filled by the association in whose committee the vacancy occurs.

5. The committee of each association shall retain its individuality as far as its association is concerned, and shall be free to report to its association as much or as little of the actions of the commission as it sees fit.

6. The commission shall be a permanent organization.

7. The commission shall elect its own chairman every two years.

Mr. C. R. Mann has been elected chairman of this commission for the next two years.

It is hoped that several other associations will appoint committees to assist in this work. The members of these committees will then become members of the commission. At present the commission is composed of forty-eight members, representing twelve associations, as follows:

C. F. Adams, Central High School, Detroit, Mich.; L. E. Akeley, University of South Dakota, Vermillion, S. D.; J. E. Almy, University of Nebraska, Lincoln, Neb.; F. H. Ayres, Central High School, Kansas City, Mo.; E. E. Burns, Medill High School, Chicago, Ill.; H. M. Campbell, High School, Long Branch, N J.; H. N. Chute, High School, Ann Arbor, Mich.; A. D. Cole, Ohio State University, Columbus, Ohio; J. A. Coolidge, English High School, Cambridge, Mass.; John Dewey, Columbia University, New York, N. Y.; W. A. Fiske, High School, Richmond, Ind.; H. M. Garrett, High School, Beatrice, Neb.; F. M. Gilley, High School, Chelsea, Mass.; C. W. Greene, Albion College, Albion, Mich.; K. E. Guthe, State University, Iowa City, Ia.; William Hallock, Columbia University, New York, N. Y.; Paul H. Hanus, Harvard University, Cambridge, Mass.; S. Hayes, High School, Lancaster, Ohio; W. A. Hedrick, Central High School, Washington, D. C.; J. W. Hutchins, High School, Malden, Mass.; J. M. Jameson, Pratt Institute, Brooklyn, N. Y.; F. S. Jones, University of Minnesota, Minneapolis, Minn.; O. C. Kenyon, High School, Syracuse, N. Y.; I. E. Kline, Blair Academy, Blairstown, N. J.; C. R. Mann, University of Chicago, Chicago, Ill.; G. H. Mead, University of Chicago, Chicago, Ill.; E. R. von Nardroff, Erasmus Hall High School, Brooklyn, N. Y.; J. P. Naylor, DePauw University, Greencastle, Ind.; H. Newcomer, Wadleigh High School, New York, N. Y.; A. T. Seymour, High School, Orange, N. J.; M. V. O'Shea, University of Wisconsin, Madison, Wis.; J. S. Shearer, Cornell University, Ithaca, N. Y.; C. H. Smith, Hyde Park High School, Chicago, Ill.; E. F. Smith, Humboldt High School, St. Paul, Minn.; B. L. Steele, High School, Marion, Ind.; O. M. Stewart, University of Missouri, Columbia, Mo.; J. S. Stokes, State Normal School, Kirksville, Mo.; A. J. Stout, High School, Topeka, Kan.; H. L. Terry, State Inspector of Schools, Madison, Wis.; S. L. Thomas, High School, Council Bluffs, Ia.; W. A. Thompson, High School, Webster, S. D.; P. T. Tompkins, Lowell High School, San Francisco, Cal.; W. E. Tower, Englewood High School, Chicago, Ill.; G. H. Trafton, High School, Passaic, N. J.; C. W. Treat, Lawrence University, Appleton, Wis.; C. M. Turton, South Chicago High School, Chicago, Ill.; J. F. Woodhull, Teachers College, New York, N. Y.; H. I. Woods, Washburn College, Topeka, Kan.